

Accounting for the wind field is an essential element of the Direct-To algorithm. The CTAS trajectory synthesizer, with its hourly wind update from National Oceanic and Atmospheric Administration's Rapid Update Cycle atmospheric model, compares flying time along the flight plan route and the direct route to identify time-saving routes. Candidate Direct-To fixes are restricted to be within a limit rectangle (1,000 x 600 miles for Fort Worth Center airspace) to prevent aircraft from deviating significantly from planned routes. For large airports within the limit region, where a direct route to the airport is not feasible, Direct-To fixes are limited to an appropriate fix along the arrival route to the airport.

Analysis of Fort Worth Center traffic data shows a potential average saving of 1,800 minutes flying time per day or about 2.5 minutes per Direct-To aircraft. A controller simulation of Direct-To was conducted at Ames in August 1999. Controller feedback was very favorable and the Fort Worth Center controller team felt the tool was ready for field-test evaluation. A functional test of the Direct-To Tool integrated with the Center Host computer was conducted at the FAA Technical Center in June 1999. The point-and-click flight plan amendment capability was demonstrated with only minor changes (three lines of code) to the CTAS/Host interface software. A provisional patent application has been filed. Future plans call for field-test evaluation of the Direct-To Tool at Fort Worth Center.

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Active Final Approach Spacing Tool Development

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In many highly congested terminal areas, air traffic controllers often do not provide optimal aircraft runway assignment, sequencing, and spacing while maintaining the public's expected level of safety. NASA and the Federal Aviation Administration (FAA) are continuing to design, develop, and deploy a software-based decision support tool (DST), called the Final Approach Spacing Tool (FAST), for terminal-area air traffic management and control of arrival aircraft. FAST incorporates advanced-knowledge engineering algorithms, accurate trajectory prediction, and a specialized graphical-user interface (GUI) to provide detailed schedule information to TRACON traffic management coordinators and commands to TRACON approach controllers. An early version of this DST, known as *Passive FAST* (pFAST), provided a reduced set of advisories, namely runway assignments and landing sequences. These advisories enabled controllers to achieve a more balanced airport, as well as throughput increases of 9%–13%. The follow-on version of this DST, known as *Active FAST* (aFAST), will provide additional tactical advisory information, namely, heading, speed, and altitude commands. These advisories, if followed, allow reduction of excess-in-trail separation between aircraft at touchdown. Continued research is required to enhance FAST so that it can provide this additional advisory information. This research includes the development of advanced scheduling algorithms and automated conflict-resolution schemes and the definition of an appropriate computer-human interface (CHI).

Figure 1 shows the aFAST GUI with a typical set of passive and active advisories. The passive advisories, runway assignment and landing sequence, are presented as yellow text in the aircraft's full datablock (FDB). In this example, AAL1109 is sequenced No. 2 to runway 18R. The active advisories, heading, and speed are presented as cyan and orange map graphics and text in the aircraft's FDB. In figure 1, the controller is being advised to start turning EGF423 to 100 degrees at the filled diamond and to start slowing DAL1105 to 210 knots IAS at the unfilled circle.

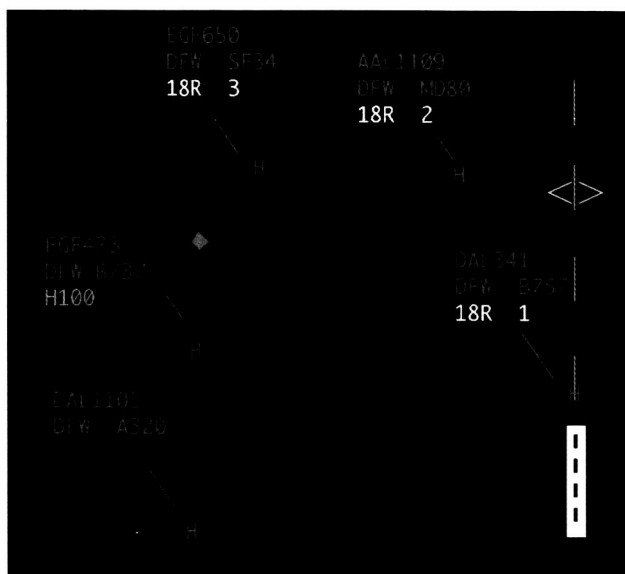


Fig. 1. aFAST graphical-user interface showing typical advisories.

During FY99, a significant amount of the aFAST software infrastructure was completed. The new design addresses several key limitations discovered during the operational testing and deployment of pFAST, and allows easier rapid prototyping of sequencing and conflict resolution logic. In addition, a method for investigating CHI requirements of the aFAST GUI, independent of the aFAST scheduling algorithms, was developed. This approach provided controllers with active advisory information replayed from recorded traffic scenarios. Though the controllers are not actively controlling the aircraft, they issue the advisories and evaluate the user interface. This method decouples the evaluations of the user interface and scheduling algorithms, while maintaining a realistic air traffic environment. A series of "shadow" simulations was conducted to evaluate advisory format, symbols, timing, and use of color. During these simulations, controller reaction times to advisory onset and command issuance were recorded. Following each scenario, questionnaires were administered to assess the usability of and workload associated with aFAST advisories. Results from the study comparing color and monochrome advisory presentation indicate that controllers noticed advisory onset more quickly when those advisories

were presented in color. Controllers also rated the color advisories as producing less screen clutter and lower mental workload.

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Distributed Air/Ground Traffic Management

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Distributed Air/Ground Traffic Management (DAG-TM) is an integrated gate-to-gate operational concept in which flight deck crews, air traffic service providers, and aeronautical operational control (AOC) personnel use distributed decision-making to enable user preferences and increase system capacity, while meeting air traffic management requirements (figure 1). The DAG-TM operational concept was developed by NASA (Ames, Langley and Glenn Research Centers) under the Advanced Air Transportation Technologies (AATT) Project, as a detailed instantiation of possible operational modes for Free Flight. It embodies the far-term vision of the AATT Project regarding air traffic operations in the National Airspace System (NAS).

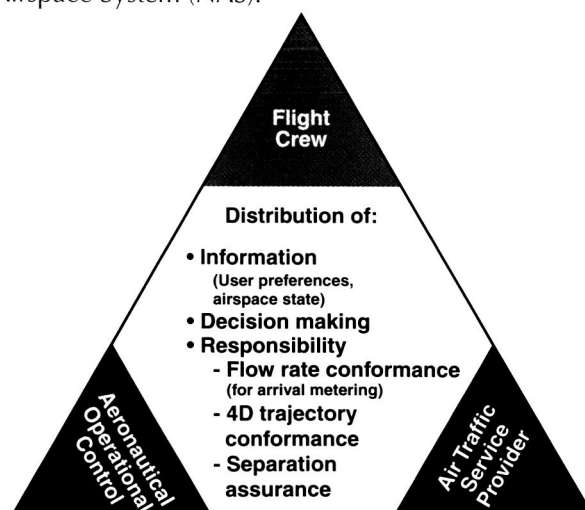


Fig. 1. The DAG-TM triad.